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ScienceDirect

Journal of Sport and Health Science 3 (2014) 170–178

www.jshs.org.cn

Review

Women and exercise in aging

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Received 22 October 2013; revised 29 January 2014; accepted 17 February 2014

Abstract

Aging is associated with physiological declines, notably a decrease in bone mineral density (BMD) and lean body mass, with a concurrent increase in body fat and central adiposity. Interest in women and aging is of particular interest partly as a result of gender specific responses to aging, particularly as a result of menopause. It is possible that the onset of menopause may augment the physiological decline associated with aging and inactivity. More so, a higher incidence of metabolic syndrome (an accumulation of cardiovascular disease risk factors including obesity, low-density lipoprotein cholesterol, high blood pressure, and high fasting glucose) has been shown in middle-aged women during the postmenopausal period. This is due in part to the drastic changes in body composition, as previously discussed, but also a change in physical activity (PA) levels. Sarcopenia is an age related decrease in the cross-sectional area of skeletal muscle fibers that consequently leads to a decline in physical function, gait speed, balance, coordination, decreased BMD, and quality of life. PA plays an essential role in combating physiological decline associated with aging. Maintenance of adequate levels of PA can result in increased longevity and a reduced risk for metabolic disease along with other chronic diseases. The aim of this paper is to review relevant literature, examine current PA guidelines, and provide recommendations specific to women based on current research.

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Keywords: Aerobic; Exercise prescription; Flexibility; Older adults; Strength training

1. Introduction

It is anticipated that there will be almost 89 million people 65 years old or above by the year 2050.[1] As the number of elderly people worldwide increases,[2] interest in health related outcomes of aging has concurrently increased. It has been suggested that an age-associated decline in physical function, cardiorespiratory fitness, and muscle mass may accelerate the physiological decline in later decades of life[3] and lead to an increase in morbidity and mortality rates.[2,4]

Women are of particular interest due to some gender differences accompanying aging, particularly as a result of menopause. Physiological decline, particularly a reduction in bone mineral density (BMD) can be attributed to estrogen deficiency as a result of menopause.[5] Reductions in BMD put older women at risk for osteoporosis which can lead to balance and gait issues, a higher risk of injury, subsequent financial costs,[6] and even a higher risk of mortality.[2] More so, a decrease in muscle strength in combination with reduced BMD can further impair balance and mobility, leading to a decline in functional capacity.[7] Thus, it becomes apparent of the need for resistance training to attenuate the decline in lean mass, muscle mass, and BMD that accompany aging and inactivity. Other physiological changes that occur with aging are alterations to the cardiovascular (CV) system, which can further impair functional capacity. Remarkably, by the age of 75 years, more than half of the functional capacity of the CV system has been lost,[8] leading to VO_{2max} values lower than that which is required for many common activities of daily

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Peer review under responsibility of Shanghai University of Sport

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http://dx.doi.org/10.1016/j.jshs.2014.02.001

living.[9] More than just leading to decreases in quality of life, low cardiorespiratory fitness has been associated with CV disease and all-cause mortality.[10−12] The CV system remains adaptable at any age,[13,14] with relative increases in VO_{2max} in older populations equivalent to those seen in younger individuals.

Physical activity (PA) has long been associated with the attenuation of physical decline associated with aging.[15] The purpose of this article is to:

1. Examine the decline in physiological variables associated with aging and a sedentary lifestyle.
2. Review recent research investigating exercise interventions on health related components in women.
3. Provide recommendations for PA that build on prior research and guidelines to improve physiological functioning in aging women.

2. Physiological decline with aging and inactivity

Aging is associated with physiological declines, notably a decrease in BMD and lean body mass (LBM), with a concurrent increase in body fat and central adiposity.[16,17] It is possible that the onset of menopause may augment the decline in physiological decline associated with aging and inactivity.[5] Wang and colleagues[18] compared almost 400 early postmenopausal women and found higher levels of total body fat, as well as abdominal and android fat in postmenopausal women. Consequently, the authors could not conclude that the changes in body fat were related to menopause or merely a result of aging alone. The authors did note, however, that changes in fat-free mass (FFM), including bone mass, may be attributed to menopause-related mechanisms, including deficiencies in growth hormones and estrogen. Douchi et al.[5] had similar findings when comparing body composition variables between pre- and post-menopausal women. The authors demonstrated an increase in percentage of body fat (30.8% ± 7.1% *vs*. 34.4% ± 7.0%), trunk fat mass (6.6 ± 3.9 kg *vs*. 8.5 ± 3.4 kg), and trunk−leg fat ratio (0.9 ± 0.4 *vs*. 1.3 ± 0.5) with aging. Concurrently, they found that lean mass (right arm, trunk, bilateral legs, and total body (34.5 ± 4.3 kg *vs*. 32.5 ± 4.0 kg)) also declined with age. Baker and colleagues[19] found that females had a greater decline in BMD with age compared to males. More so, a higher incidence of metabolic syndrome (an accumulation of cardiovascular disease risk factors including obesity, low-density lipoprotein cholesterol (LDL-C), high blood pressure, and high fasting glucose) has been shown in middle-aged women during the postmenopausal period. This is due in part to the drastic changes in body composition, as previously discussed, but also a change in PA levels. In a longitudinal study of over 77,000 (34−59 years) women spanning 24 years, van Dam et al.[20] found high body mass index (BMI, 25+) and lower levels of PA (<30 min/day of moderate to vigorous intensity activity) to be attributed with a higher risk of CV disease, cancer, and all-cause mortality. Furthermore, Sisson et al.[21] found higher levels of sedentary behavior (<4 h/day) associated with a 54% increase in risk for metabolic syndrome only in those women not meeting national guidelines.

Sarcopenia is an age related decrease in the cross-sectional area of skeletal muscle fibers that consequently leads to a decline in physical function, gait speed, balance, coordination, decreased bone density, and quality of life.[22] Additionally, due to lower levels of vigorous activity, aging populations experience notably higher losses in type II fibers than type I fibers,[23] which can reduce strength, speed, power, and overall PA. Subsequently, maintenance of muscle mass and strength is imperative to maintain a high quality level of physical functioning, and attenuate measures of frailty. Muscular adaptations to exercise (increase in muscle size, cross-sectional area, and consequent strength) may counteract muscle loss and physical decline associated with sarcopenia.

Thus it appears that PA plays a pivotal role in the attenuation of physical decline and can potentially improve physical functioning and quality of life with age.[24,25] Furthermore, maintenance of adequate levels of PA can result in increased longevity, and a reduced risk for metabolic disease along with other chronic diseases. A list of physiological changes associate with different modes of activity and their potential health outcome are listed in Table 1.[26−28]

3. CV exercise

CV disease is the major cause of death in older women.[29−31] It therefore becomes of utmost importance to decrease the risk for CV disease. Cross-sectional and intervention studies have repeatedly shown that endurance training can improve insulin sensitivity,[32,33] lower blood pressure,[34] improve lipid profiles,[35−37] and decrease body fat,[36−38] all factors related to CV disease. Furthermore, aerobic exercise has been shown to increase VO_{2max}, an index of cardiorespiratory fitness that on average decreases 5%−15% per decade after the age of 25.[39] These physiological responses to aerobic exercise results in an increased efficiency of the system during exercise (increased stroke volume, capillary, and mitochondrial density; lower heart rate and blood pressure) and ability to better deliver oxygen and glucose to working muscles.[40]

In an investigation into the level of activity that may protect against CV disease mortality, Hamer and Stamatakis[41] recruited 23,747 men and women without a known history of CV disease at baseline. The researchers tracked PA levels and causes of death over a period of 7.0 ± 3.0 years. By calculating a hazard ratio (HR), the authors found that a minimum of two sessions of moderate to vigorous PA per week was associated with a reduced risk of CV disease and all-cause mortality. Compared to active adults, those individuals who were inactive were at elevated risk of CV disease (HR of 1.41 *vs*. active: HR of 0.82) and all-cause mortality (HR of 1.50 *vs*. active: HR of 1.11). Supporting these findings, several studies have demonstrated walking, or walk−jogging, for 30−60 min, 2−5 days per week can significantly decrease body weight, increase BMD and VO_{2max}, and improve glucose levels in older women.[42−45]

Table 1
Physiological changes and health benefits associated with different modes of activity.[26–28]

Training system	Example of exercise	Physiological change	Potential health benefit
Cardiovascular training	Walking	↑Capillary density	↑Aerobic power
	Running	↑Mitochondrial density	↑Ability of body to deliver oxygen and nutrients to working muscle
	Dancing	↑Myoglobin content	↑Muscular endurance
	Soccer	↑Immune function	↑Ability to perform activities of daily living
	Swimming	↓Heart rate	↑Delay of fatigue
	Basketball	↓Blood pressure	↑Physical function
		↑Ligament strength	↓Risk of breast and colon cancer
		↑Tendon strength	↓Risk of type II diabetes
		↓Body fat %	↓Coronary heart disease
		↑Enzyme activity	
Resistance training	Weight training	↑Muscle girth	↑Strength
	Aquatic weight training	↑Muscle fiber size	↑Balance
		↑Contractile proteins	↑Posture
		↓Body fat %	↓Risk of osteoporosis
		↓Mitochondrial density	↓Risk of falls
		↑Strength and power	↓Risk of injury
		↑Bone mineral density	↑Physical functioning
		↑Size and strength of tendons	
Flexibility	Stretching exercise	↑Elasticity of tendons	↑Range of motion
	Doorway stretch		↑Ability to perform activities of daily living
	Hamstring stretch		

Although reaching current recommended PA levels (30 min of moderate activity 5 days/week, or 20 min vigorous activity 3 days/week) is sufficient for partially reducing risk factors for CV disease, it does not eliminate the additional risk that overweight/obesity poses.[46] Thus increasing levels of PA in order to improve body composition may further reduce the risk of CV disease and mortality. Martins et al.[47] found that 16 weeks of aerobic training for 45 min, 3 days per week, progressing from 40% to 50% HR reserve to 71%−85% HR reserve significantly improved waist circumference (pre: 93.3 ± 9.9 cm, post: 90.0 ± 8.6 cm), in addition to upper body strength (number of arm curl repetitions in 30 s (pre: 15 ± 4, post: 20 ± 5)), lower body strength (number of chair stand repetitions in 30 s (pre: 12 ± 4, post: 18 ± 4)) and aerobic endurance, as measured by a 6-min walk test (pre: 380 ± 75 m, post: 438 ± 85 m). Sixteen weeks after the cessation of the training program, body mass, LDL, and C-reactive protein (CRP) were significantly lower than baseline values (body mass: 73.1 ± 11.9 kg *vs*. 72.2 ± 11.4 kg; LDL: 79.8 ± 32.0 mg/dL *vs*. 55.3 ± 17.6 mg/dL; CRP: 3.38 ± 1.48 mg/L *vs*. 1.39 ± 1.35 mg/L). This highlights the need to gradually progress the intensity of aerobic training over time to allow for adequate metabolic adaptations to occur.

Evaluating different modalities for aerobic training, Bocalini et al.[48] compared the effects of land (LE) versus water-based (WE) aerobic exercise in sedentary older women over the course of 12 weeks (3 days/week at ∼70% of age-predicted HR_{max}). Although VO_{2max}, lower body strength, and agility significantly improved in both groups, only the WE group saw a significant decrease in resting HR (pre: 92 ± 2 bpm, post: 83 ± 3 bpm), a significant increase in upper body strength (arm curl test, pre: 17 ± 3 repetitions, post: 25 ± 1 repetitions), and improved markers of flexibility, both lower body (sit-and-reach, pre: 24 ± 3 cm, post:36 ± 2 cm) and upper body (back scratch, pre: −10 ± 2 cm, post: −6 ± 2 cm), suggesting its use as an alternative to traditional aerobic training. More so, walking in conjunction with other aerobic exercise forms, such as swimming, cycling, or dancing, resulted in improving VO_{2max} and blood pressure,[49] favorable changes in lipids,[49] and improved muscle strength and endurance, flexibility, and balance.[39]

4. Strength training

After the age of 30, a decrease in muscle size and thickness, along with an increase in intramuscular fat takes place.[50] The loss of muscle mass, resulting from a decreased number of muscle fibers and atrophy of remaining muscle fibers (sarcopenia), has a strong role in the loss of strength, as well as the ability to perform activities of daily living.[51,52] The decline in isometric and dynamic muscle strength is a consequence of the aging process, with approximately 30% of strength lost between the ages of 50 and 70 years.[53] Furthermore, cross-sectional data suggest that muscle strength declines by approximately 15% per decade in the 6th and 7th decade, and 30% thereafter.[54–57] Resistance training (RT) has increased its popularity among older adults because of its benefits on muscle fitness, body composition, mobility, and functional capacity. More so, regular RT can offset the typical age-associated decline in bone health by maintaining or increasing BMD and total body mineral content.[58]

Although there is little question as to the benefits of RT in an older population, there is still some disparity regarding the ideal training volume (i.e., number of sets, repetitions, and load).[59,60] Previous research has shown that older women who resistance train intensely (80% 1-RM) three times per week (whole-body RT, including elbow flexion and extension, seated row, overhead press, leg extension and curl, bench press, and sit ups) have similar improvements in FFM and total body strength. Hunter and colleagues[61] demonstrated a 1.8-kg increase in FFM for the high-resistance group, compared to an increase of 1.9 kg for the variable-resistance group. Additionally, they observed a training effect for all 1-RM tests (seated press, 26.6%; bench press, 28.5%; arm curl, 63.7%; and leg press, 37.1%). Interestingly, those who trained with a variable resistance demonstrated an increase in ease of performing daily tasks over those who trained intensely three times per week. These findings suggest that training too intensely or too frequently may result in increased fatigue and consequently a reduced training adaptation in older women due to insufficient time to recover.

Low volume training (LV, 1 set per exercise) compared to high volume training (HV, 3 sets per exercise) performed twice a week for 13 weeks induced similar improvements in maximal dynamic strength for knee extensors and elbow flexion, muscular activation of the vastus medialis and the biceps brachii, and muscle thickness for the knee extensors and elbow flexors in elderly women.[62] The authors suggest that during the initial months of training, elderly women can significantly increase upper- and lower-body strength by utilizing low volume training. However, after longer periods of training, larger muscle groups may require greater training volume to provide further strength gains.[63,64]

Allowing individuals to self-regulate their exercise intensity to a preferred intensity may lead to greater enjoyment and stronger compliance to an exercise program.[65−67] Additionally, it has been suggested that a low-intensity resistance exercise protocol may be more effective for older adults by increasing adherence rates.[68,69] Compared to a high intensity resistance exercise program, lower attrition rates were observed when training used lower intensities (70% *vs.* 80% 1-RM) and frequencies (2 *vs.* 3 days).[70] However, Elsangedy and colleagues[71] recently found that older women engaged in an RT program that allowed them to self-select their training load selected loads that were less than that recommended for improvements in muscle strength and endurance (42% 1-RM compared to 50%−70% 1-RM). While this intensity is suitable for very deconditioned individuals, it may not provide enough overload to the body to elicit changes in strength and functional capacity. Though limited data exist on the chronic effects of self-selected training load on muscular fitness and functional autonomy, a recent study by Storer et al.[72] observed significant improvements LBM, upper body strength, peak leg power, and VO_{2max} in middle-aged males using a personal trainer compared to self-training. Albeit using males, this study supports the idea that guidance from a personal trainer and the use of a progressive overload, in which intensity is gradually increased over time, may be optimal to maximize chronic positive effects.

Traditional strength training, including the use of weight machines, has been shown to induce positive changes in strength and FFM in older adults.[38,73,74] However, it becomes imperative to provide alternative methods of RT to the traditional use of weight machines, which may be more convenient for certain populations, including older women. In a recent study by Colado et al.,[75] the authors examined three forms of RT (traditional weight machines (WM), elastic bands (EB), and aquatic devices (AD)) and compared their effectiveness at improving body composition and physical capacity. Following the 10-week training program, all three groups reduced FM (WM: 5.15%, EB: 1.93%, and AD: 2.57%), increased FFM (WM: 2.52%, EB: 1.15%, AD: 0.51%), in addition to upper- and lower-body strength, with minimal differences between the different groups.

5. Flexibility

Flexibility training has been shown to improve muscle and connective tissue properties, reduce joint pain, and alter muscle recruitment patterns.[76] Although results from previous studies examining changes in flexibility following an intervention have provided mixed results, more recent studies have demonstrated significant improvements in range of motion of various joints in older adults participating in regular exercise.[77−79] While the research examining interventions for improving flexibility in an older population is limited, increases of 5%−25% have been shown following interventions using a combination of aerobic exercise, RT, and stretching.[80,81] The typical duration for each exercise session was 60 min, performed 3 days per week for 12 weeks to 1 year. Filho et al.[82] examined the effects of 16 weeks of combination (aerobic, flexibility, and resistance) training on metabolic parameters and functional autonomy in elderly women. Twenty-one women (68.9 ± 6.8 years) participated in three weekly sessions of stretching, resistance exercise, and moderate intensity walking for 16 weeks. Significant improvements in metabolic parameters, including glucose, triglycerides, total cholesterol, high density lipoproteins, LDL, blood pressure, and BMI were seen following the intervention. More so, the addition of resistance and flexibility exercises appeared to enhance functional autonomy (the ability to perform activities of daily living). Supporting these findings, Bravo et al.[80] found that flexibility, agility, strength, and endurance all significantly improved following 12 months of an exercise program, in which participants performed weight bearing exercises (walking and stepping), aerobic dancing, and flexibility exercises for 60 min three times a week. The exercise group was also able to maintain spinal BMD while control groups saw significant reductions. Furthermore, in a study by Hopkins et al.,[81] 65 older women participated in a 12-week exercise program, consisting of low-impact aerobics, stretching, and progressive dance movements. Each session was 50 min long and was performed three times per week. The exercising group significantly improved cardiorespiratory endurance, strength, balance, flexibility, agility, and body fat.

The aforementioned findings primarily include “combination” training where interventions include aerobic and/or RT with flexibility training. Thus we cannot deduce what effect flexibility training alone had. However, combination training has been shown to be just as beneficial to flexibility as flexibility training alone.[83,84] Therefore, with the positive

Table 2
PA interventions in postmenopausal women with health related fitness outcomes.[28] Adapted with permission.

Study	Groups	*n* (mean age (year))	Mode of exercise and duration of study	Training prescription	Main results
Asikainen et al.[42,91]	2 EX: EX1, EX2, and CTL, stratified by HRT	134 (57)	Walking 15 weeks	30–60 min, 65% VO_{2max} in one (EX1) or two (EX2) daily session, 5 days/week	Improvement in VO_{2max} (+2.5 mL/kg/min (EX1, EX2); improvement in diastolic BP: −3 mmHg (combined EX1, EX2), glu: −0.21 mmol/L (EX1), −0.13 mmol/L (EX2), weight: −1.2 kg (EX1), −1.1 kg (EX2), F%: −2.1% (EX1), −1.7% (EX2)
Asikainen et al.[43,91]	4 EX: EX1–4 and CTL, stratified by HRT	121 (55)	Walking 4 weeks	54 min, 55% VO_{2max} (EX1) 65 min, 45% VO_{2max} (EX2) 38 min, 55% VO_{2max} (EX3) 46 min, 45% VO_{2max} (EX4) 5 days/week	Improvement in VO_{2max}: +2.9 mL/kg/min (EX1), +2.6 mL/kg/min (EX2), +2.4 mL/kg/min (EX3), +2.2 mL/kg/min (EX4)), F% (−1.2% (EX1), −1.1% (EX2), −0.6% (EX3), −1.0% (EX4))
Brooke-Wavell et al.[44]	EX, CTL	84 (64)	Walking 1 year	20 min self-selected pace	Increased BMD (EX: +0.2, CTL: −2.0)
Busby et al.[92]	EX, Disc., EX + Disc., CTL	50 (52)	Walking–jogging 12 weeks	30 min, 60%–73% VO_{2max}	Improved VO_{2max} (4% in EX, 6% in Disc. group)
Hopkins et al.[81]	EX, CTL	65 (65)	Aerobic dance and stretching 12 weeks	15 min warm-up, 20 min low-impact EX, 15 min cool-down, 3 days/week	Increased aerobic fitness (17%), strength/endurance (62%), flex and balance (12%)
King et al.[93]	3 EX: HIG, HIH, LIH, CTL	160 (57)	Walking, jogging, cycling, treadmills 1 year	40 min, 73%–88%VO_{2max}, 3 days/week; 30 min 60%–73% VO_{2max}, 5 days/week	Increased VO_{2max} (1.5–2.3 mL/kg/min)
Ready et al.[94]	2 EX: 3 days/week, 5 days/week, CTL	79 (61)	Walking 24 weeks	60 min 60% VO_{2max}, 3 or 5 days/week	Improved VO_{2max} (12% (3 days/week), 14% (5 days/week)), weight (−0.6 kg, 3 days/week), and F% (−4.2% (3 days/week), −4.0% (5 days/week))
Shinkai et al.[95]	EX + Diet, CTL	32 (54)	Cycling, walking, jogging, swimming 12 weeks	45–60 min, 50%–60% VO_{2max}, 3–4 days/week	Decreased body mass (−6%) and F% (−10%)
Bravo et al.[80]	EX, CTL, stratified by age, etionate, and HRT	142 (60)	Walking, aerobic dancing, resistance EX (wrist weights, elastic tubes), flex coordination EX 1 year	10 min warm-up and flex EX; 25 min, aerobic training, 54%–69% VO_{2max}; 15 min EX for upper limbs and trunk, 12–15 maximal reps; 5 min EX for flex and coordination 3 days/week	Improved strength (15%) and half-mile walk time (−9%)
Chow et al.[96]	A, A + S, CTL	10 (56)	Walking, jogging, dancing, resistance EX (wrist and ankle weights) 1 year	30 min, 73% VO_{2max} (A, A + S); 10–15 min of limb and trunk EX, 10-RM, 10 reps (A + S), 3 days/week	Improved bone mass (4%–7% in A + S) and VO_{2max} (22% in A, 32% in A + S)
Irwin et al.[97]	EX, CTL	173 (61)	Walking, cycling, strength training 1 year	45 min, 75% VO_{2max}, 3 days/week	Decreased weight (−1.4 kg) and F% (−1%), increased VO_{2max} (11%)
Bemben et al.[98]	2 EX: high load, high rep, and CTL, stratified by BMD	35 (51)	Strength training (Cybex) 24 weeks	12 EX, 80% 1-RM with 8 reps (high load) or 40% 1-RM with 16 reps, 3 sets, 3 days/week	Increased muscle strength (20%–40%)
Scanlon et al.[99]	RE and CTL	26 (70)	Progressive resistance training 6 weeks	6–10 EX, 2–4 sets, 8–12 reps; ∼70–85% 1-RM and no exceed 5–6 on 1–10 RPE scale	Increased muscle strength (32%) and MQ (31%)
Conceicao et al.[100]	RE and CTL	10 (53)	Progressive resistance training 16 weeks	1st 8 weeks: 3 sets, 10 reps (60 s rest), 3 days/week; 2nd 8 weeks: 3 sets, 8 reps (90 s rest), 3 days/week	Improved F% (−6.75%), LBM (2.46%), leg press (41.29%), and bench press (27.23%)

Balsamo et al.[101]	2 EX: RE, AWB, CTL	63 (53)	60 min, 10−15 reps, 3 days/week (RE), AWB EX, 3 days/week	60 min, 10−15 reps, 3 days/week (RE), AWB EX, 3 days/week	Increased BMD (total body: 5.73%, lumbar spine: 16.4%, and femoral neck: 8.73%)
Elliott et al.[73]	RE, CTL	15 (55)	Progressive resistance training 8 weeks	5 min warm-up, 3 sets, 8 reps, 80% 10-RM, 3 days/week (RE)	Increased strength (lat pulldow: 88%), bench press (120%), knee extension (650%)
Radaelli et al.[62]	LV, HV	20 (~66)	Progressive resistance training 13 weeks	2 days/week. 1st 6 weeks: 20 reps, 1 set (LV), 3 sets (HV). Weeks 7−10: 12−15 reps, 1 set (LV), 3 sets (HV). Final 3 weeks: 10 reps, 1 set (LV), 3 sets (HV)	Increased strength (knee extension 1-RM: 31.8% ± 20.5% for LV and 38.3% ± 7.3% for HV; elbow flexion 1-RM: 25.1% ± 9.5% for LV and 26.6% ± 8.9% for HV; lower body isometric maximal strength: 3.9% ± 19.3% for LV and 14.1% ± 10.7% for HV; upper body isometric maximal strength: 20.9% ± 17.5% for LV and 16.3% ± 9.8% for HV), MT, and MQ

Abbreviations: A = aerobic; AWB = aquatic weight bearing; BMD = bone mineral density; BP = blood pressure; CTL = control; Disc. = discussion; EX = exercise; F% = body fat percent; flex = flexibility; glu = glucose; HIG = high-intensity group-based; HIH = high-intensity; HRT = hormone replacement therapy; HV = high volume; LBM = lean body mass; LIH = low-intensity hydrodensitometry; LV = low volume; MT = muscle thickness; MQ = muscle quality; RE = resistance exercise; rep = repetition; RM = maximal repetitions in resistance training; RPE = ratings of perceived exertion; S = strengthening; VO_{2max} = maximal oxygen consumption.

adaptations from RT and aerobic training, the addition of flexibility training to an exercise intervention is warranted, and may improve functional autonomy, range of motion, balance, and mobility in older women (Table 2).[26]

6. Recommendation

While current American College of Sports Medicine (ACSM) guidelines recommend light- to moderate-intensity activities to optimize health, moderate- to high-intensity exercise may be necessary to elicit positive CV adaptations and reduce the risk for CV disease. Older adults should aim to get at least 30 min of moderate activity, or 20 min of more vigorous activity (≥6 METS or 60%−<90% HRR), 3 days a week. It is recommended that programs include low-impact, large muscle, rhythmic forms of exercise, including swimming, walking, biking, and dancing. More so, women may benefit from participating in group-based fitness classes, such as step aerobics and dance classes. Social support and group cohesiveness received from group fitness classes may help to increase self-efficacy, leading to long term adherence as well as greater enjoyment and satisfaction from the exercise program.[85−87] The addition of stretching exercises (light- to moderate-intensity, hold for 30 s each muscle group, 3−4 repetitions) to these programs can serve to increase flexibility and range of motion.

ACSM recommends that older adults perform RT at least 2 non-consecutive days per week, including 8−10 exercises involving all the major muscle groups at moderate intensity (selecting a weight that allows 10−15 repetitions of each exercise), with 2−3 min of rest between each set. Additionally, those who are very deconditioned could start RT with a "very light" to "light" intensity (40%−50% 1-RM) to improve strength, power, and balance.[27] It is advised that women unfamiliar with RT consult a fitness professional prior to beginning a program. It is suggested that one must use progressive overload to stimulate muscular adaptations to resistance exercise. Typical recommendations for progression of RT is to first increase repetitions, followed by an increase in weight (0.5 kg for upper body, 1 kg for lower body) per week. For optimal results from a resistance program, the focus should be on full-body, compound movements (bench press, squat, pull-ups, *etc*.). Furthermore, adherence to group-based RT programs tends to be higher among older women than home based programs.[88,89] Additionally, Elsangedy and colleagues[71] recently found that women who self-selected resistance exercise intensity fell below current ACSM guidelines. Consequently, the participation in a supervised or group-based resistance exercise program may improve women's adherence and health benefits stemming from a higher intensity attained. Finally, the authors propose circuit training, which incorporates both RT and aerobics, as an attractive alternative for weight training. One of the major benefits to circuit training is that it can illicit the same positive physiological responses as traditional RT, thus providing a time-efficient alternative to improve muscular strength and functional fitness.[90]

Table 3
Recommendations for exercise based on current research.

Activity type	Frequency	Duration	Intensity	Examples
Aerobic	2−3 days/week	>30 min	Moderate intensity (50%−60% HR_{max}; RPE 5−6)	Walking, jogging, swimming, and dancing
Resistance	2−3 days/week	8−10 exercises; 1−3 sets each	Moderate intensity; 10−15 reps, where the last 1−2 reps are difficult to perform (RPE 5−6 for moderate, 7−8 for vigorous)	Calisthenics (body weight exercises: pushups, squats, *etc*.), resistance band exercises, circuit training, free-weight or machine weight exercise, large, multi-joint exercises
Flexibility	>2 days/week	10 min; 8−10 stretches	Light−moderate intensity; hold each stretch for 10−30 s, 3−4 reps each set. Stretch to the point of slight discomfort	Sit-and-reach, shoulder stretch

Abbreviations: HR = heart rate; RPE = ratings of perceived exertion, on a scale of 0−10 for level of physical exertion; rep = repetition.

The ACSM recommendations for flexibility are to aim for greater than 2−3 days per week, ultimately aiming for daily training. Static stretching should be held 10−30 s at a point of mild discomfort, although stretches lasting 30−60 s may provide additional benefits. Two to four repetitions per exercise are recommended, aiming for at least 60 s of stretching for each major muscle-tendon unit (Table 3).[27]

The recommendations we have provided are general. The frequency, intensity, type, and duration of exercise one is able to achieve and maintain will vary from person to person. Thus we suggest that an individualized approach be utilized. While some activity is better than none, individuals aiming to improve CV health, muscular strength and endurance, and functional mobility should strive to meet the minimum recommendations we have provided.

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